



Paleoclimate changes: a stochastic resonance model based on ice-core data analysis

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We investigate statistical properties of paleoclimate changes during the last glacial period (i.e. 20-120 kyr BP) using an EMD based approach [1]. In particular, we showed that EDML and NGRIP datasets are characterized by fast risings of temperature, known as Dansgaard-Oeschger (DO) events. By applying a potential analysis, we found the existence of two stable climate states between which the climate system oscillates during the occurrence of DO events.

We developed two different models based on the stochastic resonance mechanism in order to reproduce the switch between two stable climate states which characterize the longer timescale dynamics. The first model is based on the classical concept of the stochastic resonance in which we have a double-well potential function, describing the internal dynamics, a periodic term, characterizing the quasi-periodic behaviour of the system, and a noise term, describing the fast variables which are present into the climate system. The novelty introduced in this model is related to the potential function which is directly extracted using the EMD reconstructions obtained from the observational paleoclimate datasets [1]. Another important novelty is obtained by using a "modified" stochastic resonance model in which the fast variables are not described using a noise process but using the physical informations obtained taking into account the EMD results on the original datasets [1]. Using these two models we note that:

1. the "classical" stochastic resonance model is able to reproduce the switchings between the two stable states but these transitions are driven by a noise term which is not directly related to a physical mechanism
2. the "modified" model allows to consider the physical mechanism and the effects related to the fast variables of the system such as the occurrence of DO events, particularly evident during the last glacial period in Northern hemisphere both in observational dataset and in simulation results
3. the cross-correlation coefficient between northern and southern system variables shows a good agreement in the time-delay with respect to direct observations when the "modified" stochastic model is taken into account

References

- [1] Alberti, T., Lepreti, F., Vecchio, A., Bevacqua, E., Capparelli, V., and Carbone, V., Natural periodicities and Northern Hemisphere-Southern Hemisphere connection of fast temperature changes during the last glacial period: EPICA and NGRIP revisited, *Climate of the past*, **10**, 1751-1762, doi:10.5194/cp-10-1751-2014, 2014